METALURGICAL MATERIAL WITH FABRICATION PADS

BACKGROUND OF THE INVENTION

[0001] This invention relates to the use of metallurgical materials, particularly bi-metal strips, in industrial applications, and, more particularly, to fabrication pads attached to the strip of metallurgical material to facilitate handling and utilization thereof in commercial or industrial applications.

[0002] Seam welding of dissimilar materials edge to edge where the metals are joined perpendicularly to their length and width directions has been known for a long time. For example, saw blades consist of a hard material for the cutting surface welded to more flexible steel. Springs used for color picture tube applications use two components of differing coefficients of thermal expansion to position the shadow mask assembly.

[0003] Thermostat metals are comprised of two or more materials joined plane to plane in their length and width directions where the laminate sum up to the overall composite thickness of differing thermal, mechanical and electrical properties in that thermal input is translated to mechanical output. Layer configuration can be modified to promote one physical property without regard to other properties. For example, a thermostat metal construct may favor electrical resistivity over flexivity. Since several materials are combined, each having their own mechanical properties, some manufacturing processes (particularly welding) can cause damage to one or more layers

of the thermostat metal. This damage compromises the integrity of the material such that mechanical and/or electrical and/or thermal active length properties have been changed. Changes in the active length affect the deflection of the thermostat metal element causing variation in calibration. Changes to electrical resistance due to weld damage can cause variation in calibration where passage of electrical current is the heat rise generator.

[0004] By replacing a section of thermostat metal with a monometal that is more compatible with manufacture, fabrication damage can be minimized. Furthermore, there are some applications where the heat balance of the system would benefit from a higher or lower resistive material in contact with the terminal. There are also applications where a less expensive material can replace a segment of the bi-metal. There are some applications where the latching surface of the bi-metal element is susceptible to wear. By electron beam welding a material with better wear resistant properties, the life of the product can be increased. Calibration improvements can be achieved by controlling, for example, the active length and weld heat affecting zone creating a more uniform manufacturing condition.

[0005] Furthermore, manufacturing is simplified by providing compatible material combinations for fabrication as some fabrication methods and materials are not compatible. Through the addition of another more compatible material as a replacement, manufacturing can be accomplished. For example, manganese bearing (typically, but not

limited to, using a common alloy comprised of 72% manganese, 18% copper and 10% nickel) bimetal materials are difficult to weld or plate.

[0006] In order to enhance manufacturability, several methods are currently used. One method is to add a layer to the bi-metal construction, which enhances fabrication, such as a copper or nickel outside layer. This method is more difficult to fabricate, adding a fourth or fifth layer to the construction. Furthermore, additional layers make some fabrication and calibration steps more difficult (for example: resistance welding or brazing) due to the change in heat balance and resistance considerations. Another similar method is to plate the strip or stamped parts, using the plating as a flux for welding. Plating has become increasingly more expensive and generates complex environmental concerns. Furthermore, some materials, like manganese bearing materials, present plating challenges due to alloy incompatibility with plating chemistry.

[0007] Additional secondary steps are known, though of limited value and at substantial cost, including providing additional layers on the outside of the metallurgical material where copper, nickel or a nickel-chromium-iron alloy is used as a protective layer, such as for example the 22-3 cap layer used in R650 material. Skived material with overlay or inlay for specific properties is also used in limited applications. Plating is used to protect the surface of the metallurgical material for fabrication purposes. Plating can also work as a flux in welding and brazing. Most circuit breaker applications of bi-metal thermostat material are bright acid tin-plated. Electron beam welding thermostat metals

to thermostat metals is used to join materials with different properties. It is also used for controlling the motion direction in certain applications. Electron beam welded bi-metal materials are commonly used for stack switch thermostat metal elements.

[0008] Accordingly, it would be desirable to provide an ability to consistently fabricate bi-metal or other difficult monometallic materials into industrial applications without damaging the material or incurring operational inconsistencies due to damage from fabrication techniques.

SUMMARY OF THE INVENTION

[0009] It is an object of this invention to overcome the aforementioned disadvantages of the known prior art by providing a fabrication pad for metallurgical materials.

[0010] It is another object of this invention to provide a method of manufacturing metallurgical materials to enhance industrial utilization for the materials.

[0011] It is still another object of this invention to provide a method of manufacturing thermostat metals by electron beam welding fabrication pads to the thermostat metals.

[0012] It is a feature of this invention that the electron beam welding enhances the ability to fabricate the combination of thermostat metals and a monometal fabrication pad.

[0013] It is an advantage of this invention that the combination of a bi-metal thermostat material and a monometal fabrication pad provides a consistent thermal active length and mechanical properties.

[0014] It is another feature of this invention that the addition of electron beam welded fabrication pads to metallurgical materials improves the mechanical operations of the materials.

[0015] It is another advantage of this invention that the electrical and thermal characteristics and active length of the thermostat materials are improved.

[0016] It is still another feature of this invention that a consistent fabrication condition is provided.

[0017] It is still another advantage of this invention that the need for plating of bi-metal materials is eliminated as an aid to fabrication of the material into an industrial application.

[0018] It is yet another advantage of this invention that the heat balances of a thermostat material can be controlled.

[0019] It is a further advantage of this invention that the local wear properties of the metallurgical materials are enhanced.

[0020] It is yet another feature of this invention that the electrical contact area of a thermostat material is part of the overall assembly.

[0021] It is still another feature of this invention that the fabricated bi-metal material provides for an improved calibration for the final thermal or electrical assembly of the material.

[0022] It is yet another advantage of this invention that the size of a bi-metal strip can be reduced since the effective length of the bi-metal is not affected by the fabrication activities.

[0023] It is a further feature of this invention that the provision of monometal fabrication pads to permit a shortened bi-metal strip without detriment to the operation of the bi-metal strip results in reduced cost for bi-metal products.

[0024] It is still another object of this invention to provide a circuit breaker having a bi-metal thermostat strip incorporating the principles of the instant invention.

[0025] It is a further object of this invention to provide a method of utilizing a bi-metal strip in industrial applications by utilizing the fabrication pads for all fabrication activities for the composite bi-metal strip.

[0026] It is yet another object of this invention to provide a metallurgical material having fabrication pads that are electron beam welded to the metallurgical material that is durable in construction, inexpensive of manufacture, carefree of maintenance, facile in assemblage, and simple and effective in use.

[0027] These and other objects, features and advantages are accomplished according to the instant invention by providing a fabrication pad for metallurgical

material that is electron beam or laser welded to at least one end of the metallurgical material. The fabrication pad is formed of a monometallic material or other suitably chosen material and can be welded to a bi-metal strip to provide a fabrication contact area when the bi-metal strip is utilized in an industrial application. The fabrication pad eliminates the need for plating as an aid to fabrication and eliminates damage to the metallurgical material caused by fabrication activities directly on the metallurgical material. The assembly improves calibration and provides a consistent mechanical output. When used in an electrical circuit breaker, the assembly provides a consistent thermal active length and consistent thermal activities.

BRIEF DESCRIPTION OF THE DRAWINGS

[0028] The advantages of this invention will become apparent upon consideration of the following detailed disclosure of the invention, especially when taken in conjunction with the accompanying drawings wherein:

[0029] Fig. 1 is an elevational view of a bi-metal metallurgical strip having a fabrication pad electron beam welded to the metallurgical strip according to the principles of the instant invention;

[0030] Fig. 2 is a plan view of the bi-metal metallurgical material shown in Fig. 1;

[0031] Fig. 3 is an elevational view of a metallurgical material having a fabrication pad electron beam welded to opposing ends of the material;

[0032] Fig. 4 is a plan view of the metallurgical material depicted in Fig. 3, with the metallurgical material being monolithic having a fabrication pad welded at one end and a contact member welded at the opposing end;

[0033] Fig. 5 is a perspective view of a prior art bi-metal thermostat strip used in an electrical circuit breaker;

[0034] Fig. 6 is a perspective view of a bi-metal thermostat strip having fabrication pads mounted on opposing ends thereof according to the principles of the instant invention for use in an electrical circuit breaker; and

[0035] Fig. 7 is a schematic cross-sectional view of a circuit breaker in which a thermostat strip incorporating the principles of the instant invention, as shown in Fig. 6, is deployed.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0036] Referring to Figs. 1 – 4, a bi-metal metallurgical strip 10 having a fabrication pad 20 electron beam welded to one or both opposing ends of the metallurgical strip according to the principles of the instant invention can best be seen. The bi-metal metallurgical strip 10 is formed of a pair of dissimilar metallic layers 12, 14 that are welded to one another in a conventional manner to form an integral metallic strip 10 that will have predictable mechanical output as a result of disparate thermal expansion properties of the dissimilar metal layers 12, 14. In one embodiment, as depicted in Figs. 1

and 2, a fabrication pad 20 is welded onto one end edge 15 of the metallurgical strip 10 by electron beam welding or by laser welding to be integral with the two metallic layers 12, 14. In Figs. 3 and 4, a second embodiment of the instant invention is depicted wherein a fabrication pad 20 is welded to one end of a monolithic metallurgical strip 17 through electron beam or laser welding techniques and a contact pad 21 is welded to the opposing end of the metallurgical strip 17. The metallurgical material can be either bi-metal (preferable) or a monolithic material; however, the welding of either one or two fabrication pads 20, or a fabrication pad 20 and a contact member 21, to the respective ends is not limited to the type of metallurgical material being used.

[0037] The bi-metal strip depicted in Figs. 1 – 4 may be utilized as a thermostat metal 10 with the fabrication pad 20 being preferably a copper alloy, a stainless steel, or another suitable metallurgical material or alloy. The weld area in the final assembly governs the size of the fabrication pad 20. As is reflected in Figs. 4 and 6, a contact member 21, as an alternative to or a variation of the fabrication pad 20, can be welded to the end of the metallurgical material simply to make electrical contact without being the material being sturdy enough to undergo fabrication activities.

[0038] For example, a composite material comprised of 36% nickel, 64% iron on one side which is metallurgically bonded to a strip of 72% manganese, 18% copper, and 10% nickel on the other side, can be welded to a fabrication pad 20 of 304 L stainless steel with both the fabrication pad 20 and the composite material strip 10 being 0.050

inch thick. Welding can be accomplished on a Techmeta Project 188 welder using CT4 triode guns at 60kV with a maximum power of 6kW. This material can be stamped into a circuit breaker element and fabricated. Parts made solely from a composite material comprised of 36% nickel, 64% iron on one side which is metallurgically bonded to a strip of 72% manganese, 18% copper, and 10% nickel on the other side, are difficult to weld or braze and then calibrate. This particular composite material cannot be plated using standard industrial plating techniques without degradation of the plating bath solution or the material substrate to be plated. By selecting a material for the fabrication pad 20 that is more favorable for fabrication, plating would not be necessary.

[0039] In another example, a composite material of 36% nickel balance iron layer, a copper layer, and a 72% manganese, 18% copper, and 10% nickel layer was welded to a fabrication pad of phosphor bronze. The thickness of this fabrication pad 20 does not need to be as thick as the composite material 10, as closer calibration results along with a greater ease of fabrication was still available. In another example, the composite material was comprised of a 36% nickel balance iron layer, a copper layer, and a layer of 20% nickel, 6% manganese, and 74% iron, which was welded to a fabrication pad 20 of phosphor bronze. Calibration results and ease of fabrication were improved with this exemplary composite material also.

[0040] In the way of further examples, a thermostat metal comprised of 36% nickel, 64% iron bonded to copper bonded to 20% nickel, 6% manganese, 74% iron with

an electrical resistivity of 300 ohms per circular mil foot welded to phosphor bronze as the fabrication pad 20, both at 0.46" thick for a circuit breaker element for a Siemens residential circuit breaker 30. The electron beam welded material comprises of 16% of the length replaced by the phosphor bronze material fabrication pad 20. A copper braid is then welded to the phosphor bronze fabrication pad 20.

[0041] A thermostat metal comprised of equal parts of 36% nickel and 64% iron bonded to 22% nickel, 6% manganese, 74% iron welded to phosphor bronze on one end and contact tape on the other end for use in a First Technology automotive circuit protector. The thermal element is 0.020" thick by 0.156" wide and 0.800" long. When activated, the bi-metal deflects to separate the contacts and open the circuit. This configuration provides an assembly with uniform deflection and resistance characteristics and an ease in fabrication.

[0042] ASTM B388 standard defines some representative bi-metals. Typical bi-metals used as thermostat material in circuit breakers and the like are comprised of either a low expansion component selected from (1) 36% nickel balance iron, 39% nickel balance iron, 42% nickel balance iron; (2) a center layer of nickel or copper if a center layer is present to control electrical and thermal properties; and (3) a high expansion component selected from 22% nickel 3% chromium balance iron, 20% nickel 6% manganese balance iron, 25% nickel 8% chromium balance iron, and 72% manganese, 18% copper, and 10% nickel.

[0043] Brazing the terminal 22 or a support 24 to the bi-metal thermostat strip 32 for use of the bi-metal strip 10 in a circuit breaker 30 application has been difficult to achieve with consistent results. Prior art approaches to add a plating material to aid in the fabrication or to place a copper strip on the outside layer are not acceptable from a practical standpoint. Plating is too difficult and destroys the plating bath due to oxidation sensitivity of conventional bi-metal material incorporating a layer of 36% nickel balance iron layer, a copper layer, and a 72% manganese, 18% copper, and 10% nickel. Placing a copper layer on the outside is expensive and difficult to manufacture.

[0044] By providing a fabrication pad 20 that is edge welded to the bi-metal strip 10 and formed of metal that is compatible with the desired fabrication efforts of the bi-metal material 10, a better surface for attaching a terminal 22 to the bi-metal strip 10 can be obtained. Preferably, the fabrication pad 20 is formed of a non-thermally active metal, but one that is compatible with the fabrication process. A variation of the fabrication pad 20 is a contact member 21 that is formed of a material, such as a silver plated metal, that is used simply to make an electrical contact, as the silver plating would not survive fabrication activities. The contact member 21 can be of any appropriate shape or configuration, but is shown in the drawings as being substantially the same shape as the fabrication pad 20, the primary difference being the material and the utilization of the pad 20, 21. Accordingly, the embodiment of the invention represented in Fig. 6, for example, can use a fabrication pad 20 welded to one end of the bi-metal strip 10 for use in the

fabrication process of brazing a copper braid 22 thereto, and either a fabrication pad 20 at the opposing end for attachment to the support member 24 or a contact member 21 for simply contacting the support member 24 to make electrical contact therewith.

[0045] Utilization of the instant invention can be particularly advantageous in circuit breakers 30, such as is depicted in Fig. 7. The circuit breaker 30 has a first terminal 34 and a second terminal 36 interconnected by a trigger mechanism 35 and a bi-metal thermostat strip 32. A copper braid 38 is brazed to the fabrication pad 20 at the deflection end of the thermostat strip 32 and to the trigger mechanism 35 to transmit electrical current therebetween. The thermostat strip 32 is also connected to the second terminal through the support member 39, preferably via a second fabrication pad 20 which could be in the form of a contact member 21. As noted above, the fabrication activities of brazing the copper braid 38 to the bi-metal thermostat strip 32 and attachment to the support member 39 are accomplished through connection to respective fabrication pads 20 without causing any damage to the bi-metal portion of the thermostat strip 32. The operation of the thermostat strip 32 deflects upon the passage of excessive electrical current therethrough due to the generation of heat causing the bi-metal thermostat strip 32 to deflect and disconnect the two terminals 34, 36 through the triggering mechanism 35, which can be reset by the external switch 31.

[0046] For use in low amp circuit breakers 30, the fabrication pad 20 can be 304 L stainless steel, which has shown to provide satisfactory results. For high amp circuit

breakers 30, the fabrication pad 20 is preferably formed of copper or a copper alloy. A series of materials could be welded to a copper alloy fabrication pad, including plated steel cupro-nickel and others.

[0047] Adding a second fabrication pad 20 to the opposing end edge 15 of the bi-metal strip 10 provides additional advantages in the utilization of the bi-metal or composite material in an industrial application. The bi-metal mass can be reduced as the active length is not reduced because of fabrication techniques directly on the bi-metal material. In fact, the replacement of a portion of the bi-metal mass that would be used conventionally with a substantially less expensive metal alloy fabrication pad provides significant cost reduction. Since plating would not be necessary to permit the metallurgical composite material to be fabricated, a large cost savings, as well as associated environmental advantages, can be achieved. Placing the copper layer on the outside of the composite material just to facilitate brazing techniques would no longer be necessary.

[0048] Brazing some composite metallurgical materials, such as a stainless steel terminal being brazed onto a thermostat material comprised of 36% nickel and 64 % iron bonded to 72% manganese, 18% copper, and 10% nickel, is difficult due to the fumes generated from the flux used in the brazing process, and the fact that the composite material is not metallurgical compatible. By electron beam welding at least one

fabrication pad on the end of this thermostat material, brazing to the metallurgical composite material is not necessary.

[0049] It will be understood that changes in the details, materials, steps and arrangements of parts which have been described and illustrated to explain the nature of the invention will occur to and may be made by those skilled in the art upon a reading of this disclosure within the principles and scope of the invention. The foregoing description illustrates the preferred embodiment of the invention; however, concepts, as based upon the description, may be employed in other embodiments without departing from the scope of the invention.